CLAIMS

1. A method for purifying a metal, comprising:

providing an electrolysis cell having an anode and a cathode, the anode comprising the metal that is to be purified;

anodically dissolving the metal from the anode into an electrolyte solution as a metal ion electrolyte;

after the dissolving, passing at least some of said electrolyte solution across an ion exchange resin to reduce a concentration of one or more impurities in the electrolyte solution relative to a concentration of the metal ion in the electrolyte solution, the electrolyte being passed across the resin under conditions in which the metal ion is not loaded on the resin but instead flows across the resin, and in which one or more impurities are retained on the resin; and

after passing the at least some of the electrolyte solution across the resin, transferring said electrolyte back to said electrolysis cell and cathodically depositing the metal from the metal ion of the electrolyte at the cathode.

2. The method of claim 1 wherein the resin is in the form of a bed of ion-exchanging material packed within at least one column.

3. The method of claim 1 wherein the resin is in the form of a bed of DOWEX™ anion-exchanging material packed within at least one column.

4. The method of claim 1 wherein the cell comprises an anode compartment separated from a cathode compartment by a membrane.

5. The method of claim 4 further comprising a continuous flow of the electrolyte solution from the anode compartment, across the ion exchange resin, and into the cathode compartment during the anodically dissolving and cathodically depositing.

6. The method of claim 1 wherein the cathode has a surface exposed to the electrolyte during the cathodically depositing, and further comprising forming a non-conductive material around a periphery of the surface before the cathodically depositing.

7. The method of claim 1 wherein the metal is cobalt.

8. The method of claim 7 wherein said electrolysis cell is separated into an anode chamber and a cathode chamber with an anionic exchange membrane.

9. The method of claim 7 wherein the electrolyte solution comprises one or both of Cl^- and SO_4^{2-}.

10. The method of claim 7 wherein the anode current density during the anodically dissolving is from about $10A/ft^2$ to about $500A/ft^2$.

11. The method of claim 7 wherein the cathode current density during the cathodically depositing is from greater than $0A/ft^2$ to about $50A/ft^2$.

12. The method of claim 7 wherein the cathode current density during the cathodically depositing is from greater than $0A/ft^2$ to about $20A/ft^2$.

13. The method of claim 7 wherein the ion exchange resin has a bed volume, and wherein the electrolyte is passed through the ion exchange resin at a flow rate of greater than 0 BV/Hr, and less than or equal to about 10 BV/Hr.

14. The method of claim 7 wherein the ion exchange resin has a bed volume, and wherein the electrolyte is passed through the ion exchange resin at a flow rate of greater than 0 BV/Hr, and less than or equal to about 1 BV/Hr.

15. The method of claim 7 further comprising, after the passing said electrolyte solution across an ion exchange resin and before the cathodically depositing:

extracting cobalt electrolyte from the electrolyte solution by extraction of the cobalt electrolyte into an organic solvent;

extracting of the cobalt electrolyte from the organic solvent and into an aqueous solution; and

transferring the cobalt electrolyte to the electrolysis cell.

16. The method of claim 7 further comprising, prior to passing the electrolyte through the ion exchange resin, removing Fe from the electrolyte solution.

17. The method of claim 7 further comprising, prior to passing the electrolyte through the ion exchange resin, precipitating Fe from the electrolyte solution.

18. The method of claim 7 further comprising, after passing the electrolyte through the ion exchange resin and before cathodically depositing cobalt, removing Fe from the electrolyte solution.

19. The method of claim 7 further comprising, after passing the electrolyte through the ion exchange resin and before cathodically depositing cobalt, precipitating Fe from the electrolyte solution.

20. An apparatus for purifying a metal, comprising:

an electrolysis cell having an anode compartment and a cathode compartment, the anode compartment and cathode compartment being in electrical connection with one another through an electrolyte solution;

at least one anionic exchange membrane extending into the electrolyte solution and separating the anode compartment from the cathode compartment, the cathode compartment extending to a height above the anode compartment, the membrane extending to a height between the heights of the anode compartment and the cathode

compartment such that electrolyte fluid within the cathode compartment can flow over the membrane and into the anode compartment;

an anode within the anode compartment, the anode comprising an impure form of the metal; and

an ion exchange resin in fluidic communication with the electrolyte solution of the cathode compartment.

21. The apparatus of claim 20 wherein the metal that is to be purified is cobalt and wherein the anode comprises an impure form of cobalt.

22. The apparatus of claim 20 wherein the metal that is to be purified is cobalt and wherein the anode comprises an impure form of cobalt in at least one basket.

23. The apparatus of claim 22 wherein the basket has an iridium oxide coating.

24. The apparatus of claim 20 further comprising:

a fluid passageway from the anode compartment to the ion exchange resin; and

at least one pump along the fluid passageway and configured to pump electrolyte from the anode compartment to the ion exchange resin, and further configured to pump electrolyte from the ion exchange resin to the cathode compartment.

25. A high-purity cobalt material comprising less than 50 ppm total metallic impurities, and less than 0.05 ppm Cr.

26. The cobalt material of claim 25 in the shape of a sputtering target.

27. A cobalt film deposited from the sputtering target of claim 26.

28. The cobalt material of claim 25 comprising less than 0.01 ppm Cr.

29. The cobalt material of claim 25 comprising less than 25 ppm total metallic impurities.

30. The cobalt material of claim 25 comprising less than 25 ppm total metallic impurities, and less than 0.01 ppm Cr.

Sub B1

31. A high-purity cobalt ~~material comprising 99.99% cobalt and a sum total of Mg, Al, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Nb, Mo, W and Pb of less than 50 ppm.~~

32. The cobalt material of claim 31 comprising less than 1 ppb of Th, and comprising less than 1 ppb of U.

33. The cobalt material of claim 31 in the shape of a sputtering target.

34. A cobalt film deposited from the sputtering target of claim 33.

35. The cobalt material of claim 31 wherein the sum total is less than 40 ppm.

36. The cobalt material of claim 31 wherein the sum total is less than 30 ppm.

37. The cobalt material of claim 31 wherein the sum total is less than 25 ppm.

Sub B2

38. A cobalt material comprising greater than 99.9% cobalt and less than 0.5 ppm each of Na and K, less than 8 ppm of Fe, less than 3 ppm of Ni, less than 1 ppm of Cr, less than 1 ppm of Ti and less than 450 ppm of O.

39. The cobalt material of claim 38 comprising greater than 99.99% cobalt.

40. The cobalt material of claim 38 in the shape of a sputtering target.

41. A cobalt film deposited from the sputtering target of claim 40.

Sub B3

42. A high-purity cobalt material comprising less than 50 ppm total metallic impurities, and less than 3 ppm Ti.

43. The cobalt material of claim 42 in the shape of a sputtering target.

44. A cobalt film deposited from the sputtering target of claim 43.

45. The cobalt material of claim 42 comprising less than 0.5 ppm Ti.

46. The cobalt material of claim 42 comprising less than 0.04 ppm Ti.

47. The cobalt material of claim 42 comprising less than 0.01 ppm Cr.

48. The cobalt material of claim 42 comprising less than 0.01 ppm Cr, and comprising less than 1 ppm P.

49. The cobalt material of claim 42 comprising less than 0.5 ppm Ti, comprising less than 0.01 ppm Cr, and comprising less than 0.08 ppm P.

add B4